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Chang et al.

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(54) **ELECTRIC APPLIANCE WITH A PTC HEATING MEMBER AND A METHOD OF OPERATING SAME**

(75) Inventors: **Daniel Kee Hung Chang**, Hong Kong (HK); **Rhoda Chor Man Yue**, Hong Kong (HK)

(73) Assignee: **Halo Company, Ltd.**, Hong Kong (HK)

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(30) **Foreign Application Priority Data**

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(51) **Int. Cl.**[7] **H05B 1/02**; H05B 3/02
(52) **U.S. Cl.** **219/482**; 219/222; 219/505
(58) **Field of Search** 219/222, 240, 219/242, 531, 241, 508, 505, 486, 468.1, 494, 504, 506, 533, 543, 225, 489, 492; 362/183; 363/61, 143

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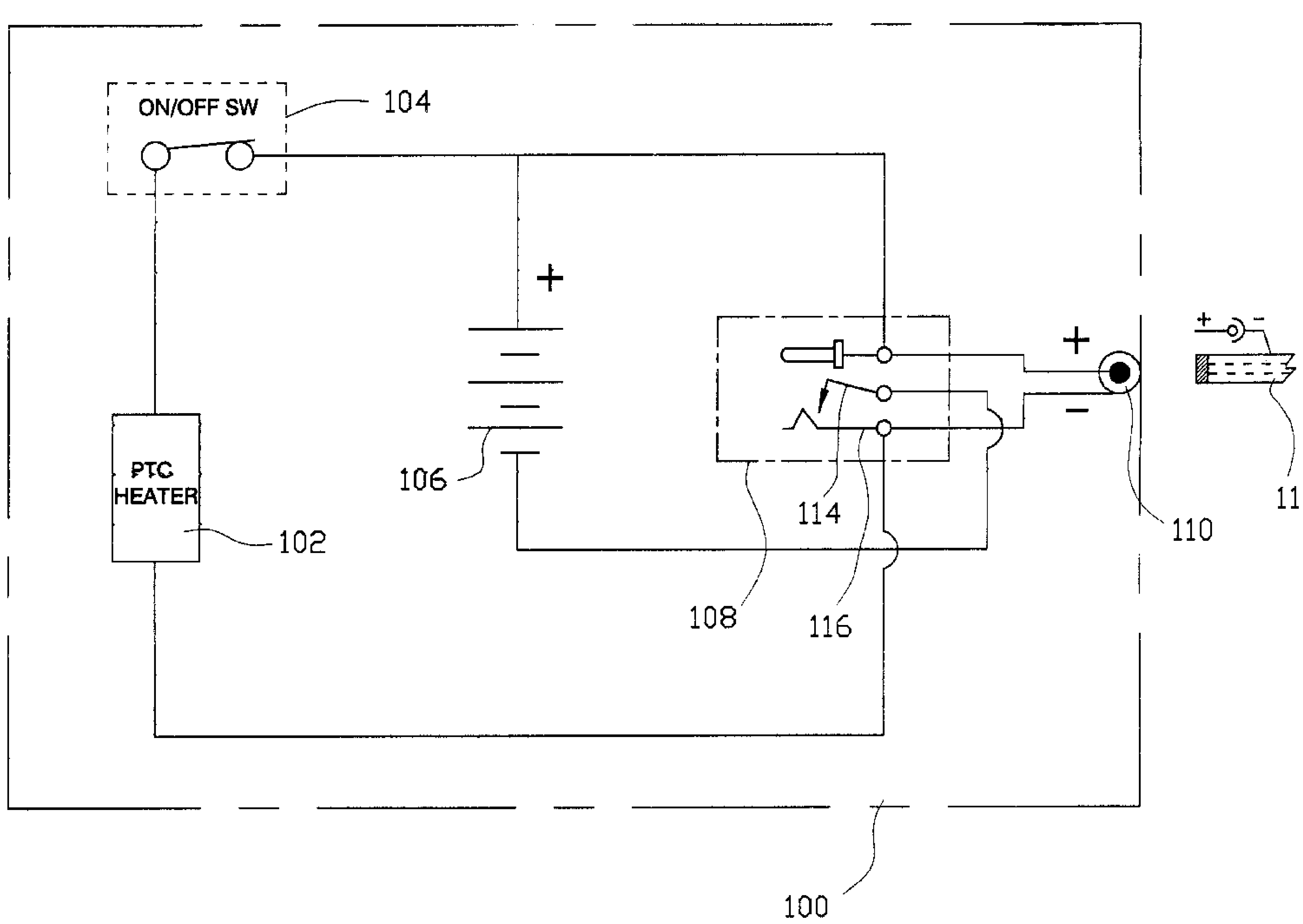
Primary Examiner—Tu Ba Hoang
(74) *Attorney, Agent, or Firm*—Reese Taylor

(57) **ABSTRACT**

There is disclosed an electric appliance (**100, 200, 300, 400, 500, 600, 700, 800**) with a positive temperature coefficient (PTC) heater (**102, 202, 302, 506, 702**) and a number of batteries (**106, 206, 308, 406, 508, 606, 708, 806**), in which the PTC heater (**102, 202, 302, 506, 702**) is adapted to be powered by the batteries (**106, 206, 308, 406, 508, 606, 708, 806**) and an outside electric power source, and the PTC heater (**102, 202, 302, 506, 702**) is adapted to be powered by the outside electric power source when the electric appliance (**100, 200, 300, 400, 500, 600, 700, 800**) is started, and to be subsequently powered by the batteries (**106, 206, 308, 406, 508, 606, 708, 806**).

41 Claims, 11 Drawing Sheets



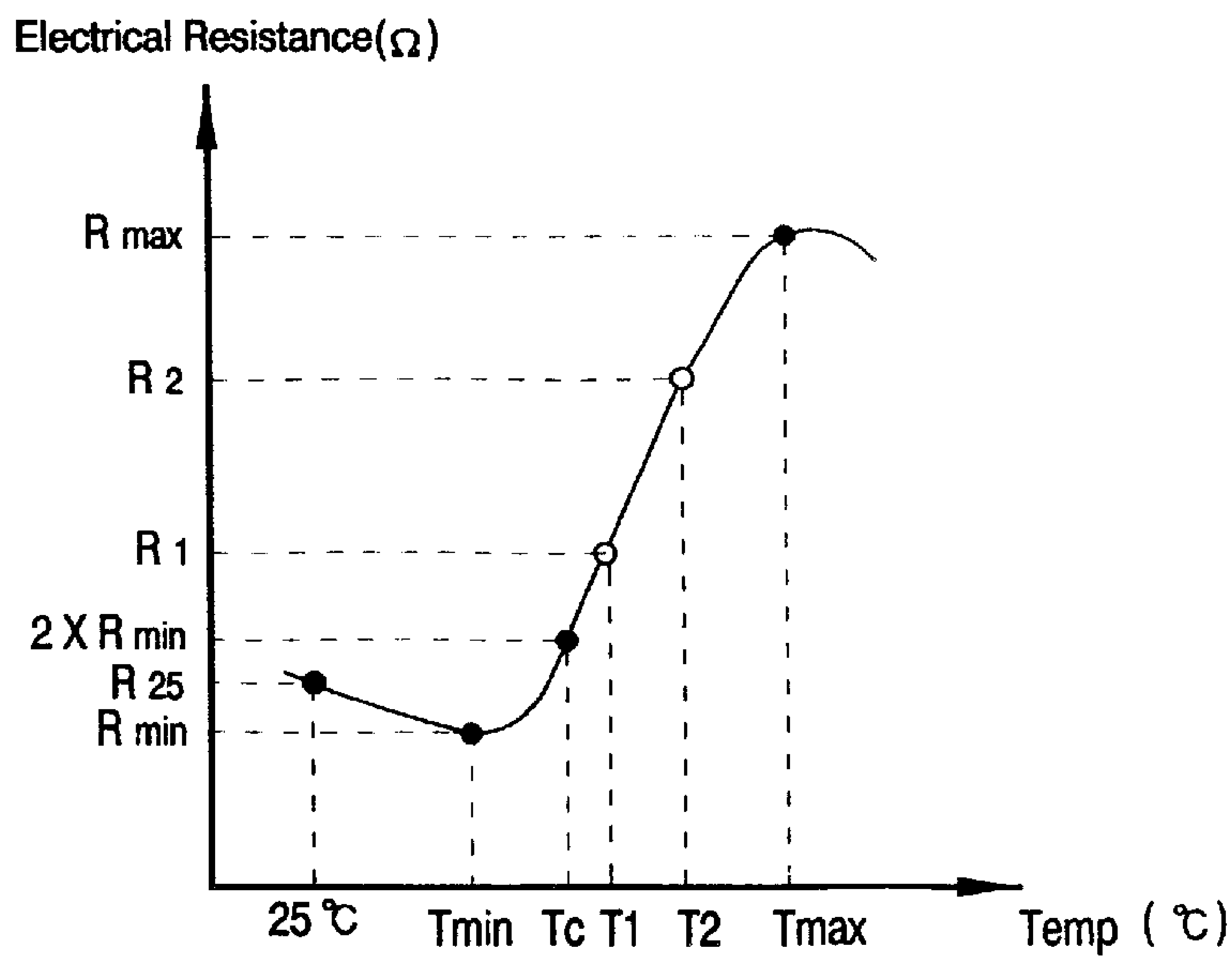

Electrical Resistance(Ω)
R max
R 2
R 1
2 X R min
R 25
R min
25 ℃
Tmin
Tc
T1
T2
Tmax
Temp (℃)

Fig.1

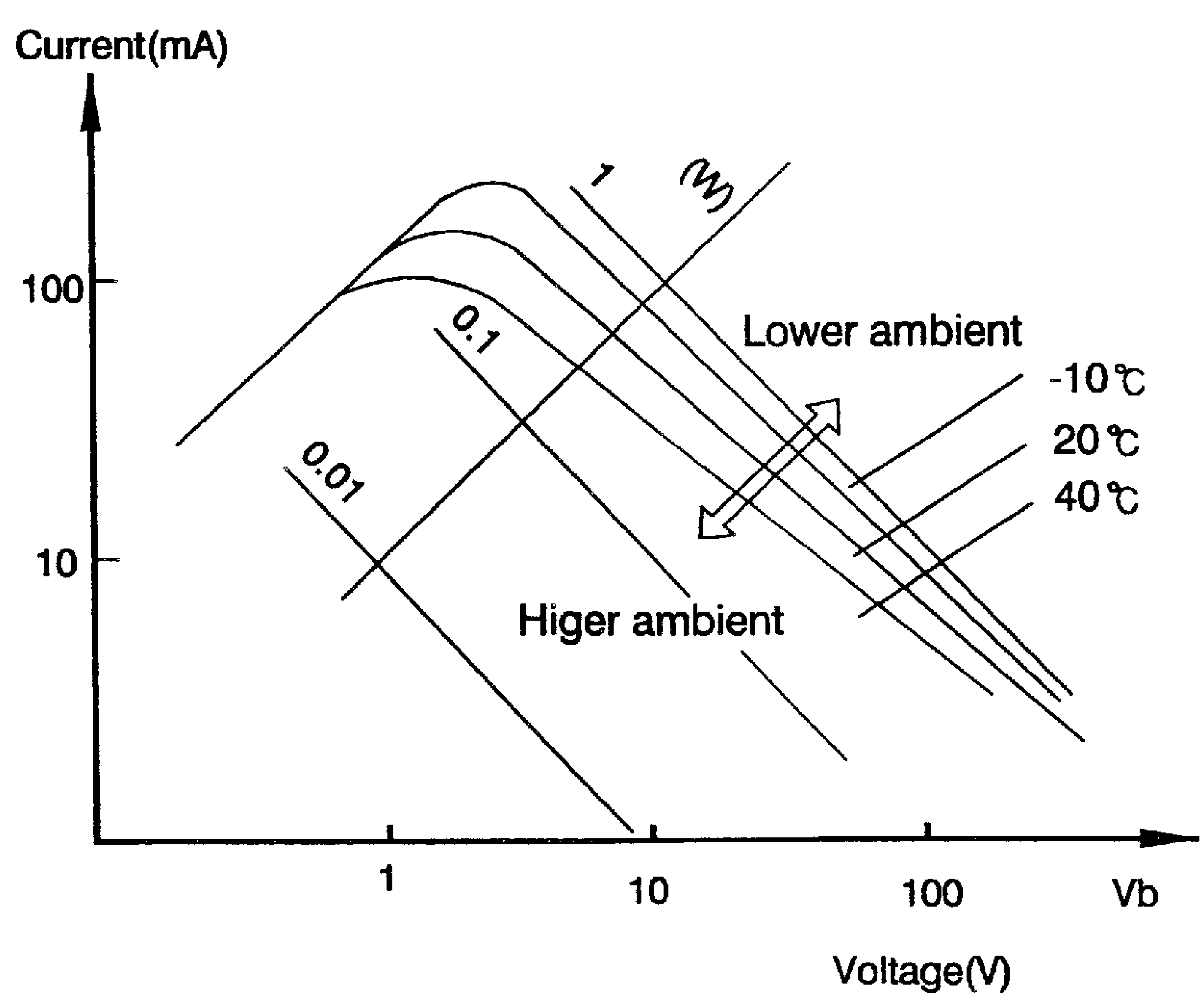

Current(mA)
100
10
1
(W)
0.1
0.01
Lower ambient
-10℃
20℃
40℃
Higer ambient
1
10
100
Vb
Voltage(V)

Fig.2

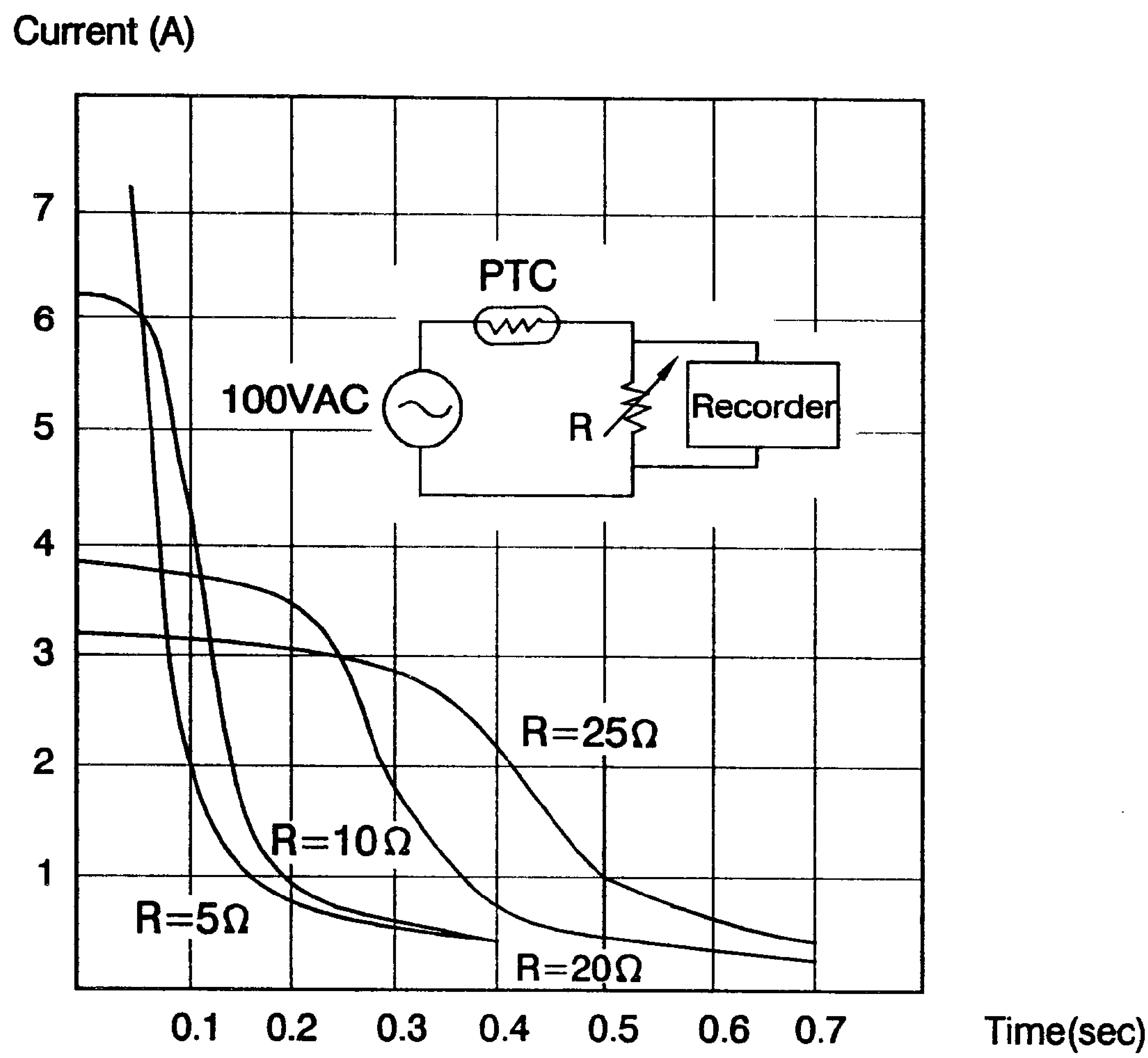

Current (A)
7
6
5
4
3
2
1
PTC
100VAC
R
Recorder
R=25Ω
R=10Ω
R=5Ω
R=20Ω
0.1 0.2 0.3 0.4 0.5 0.6 0.7
Time(sec)

Fig.3

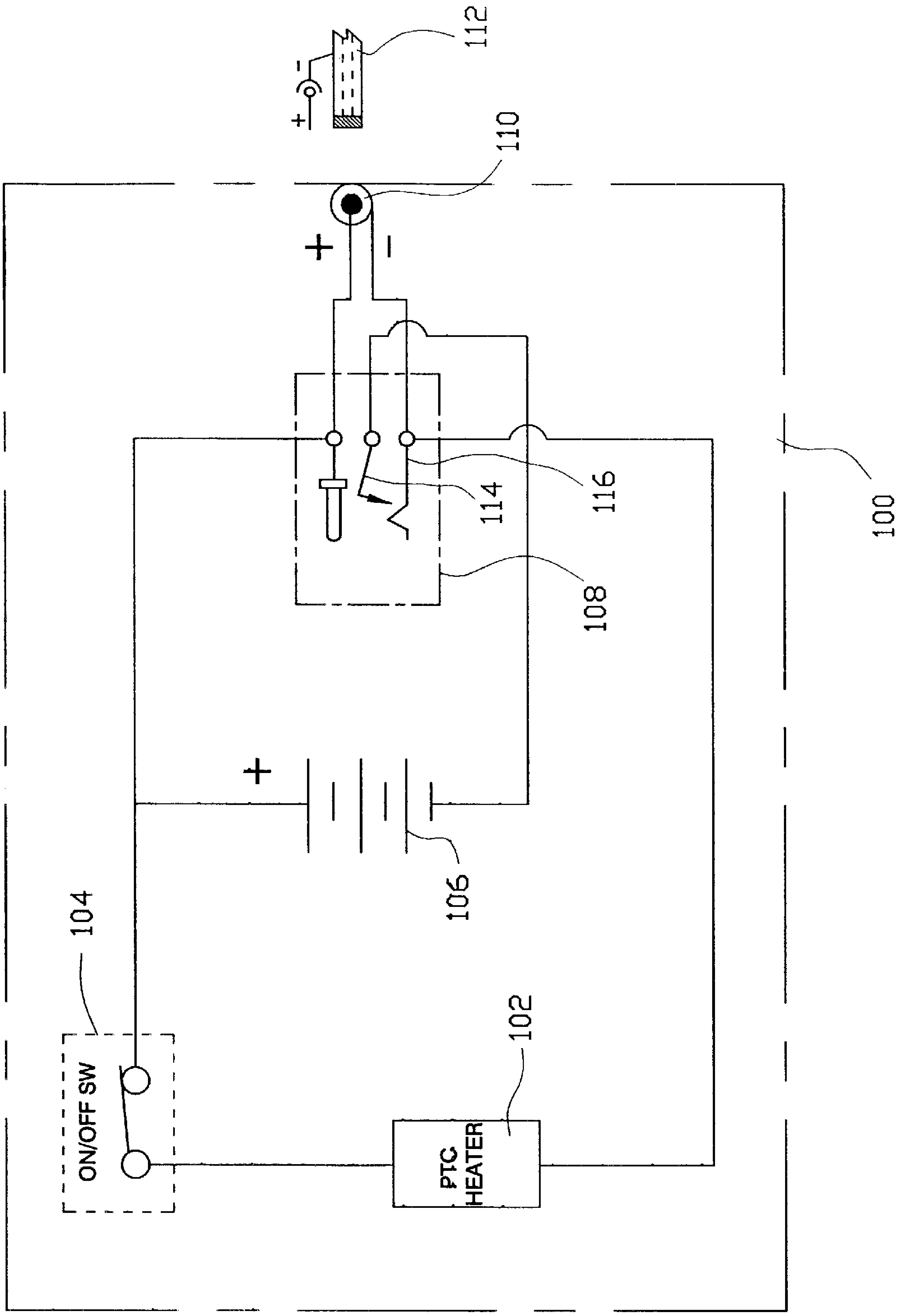
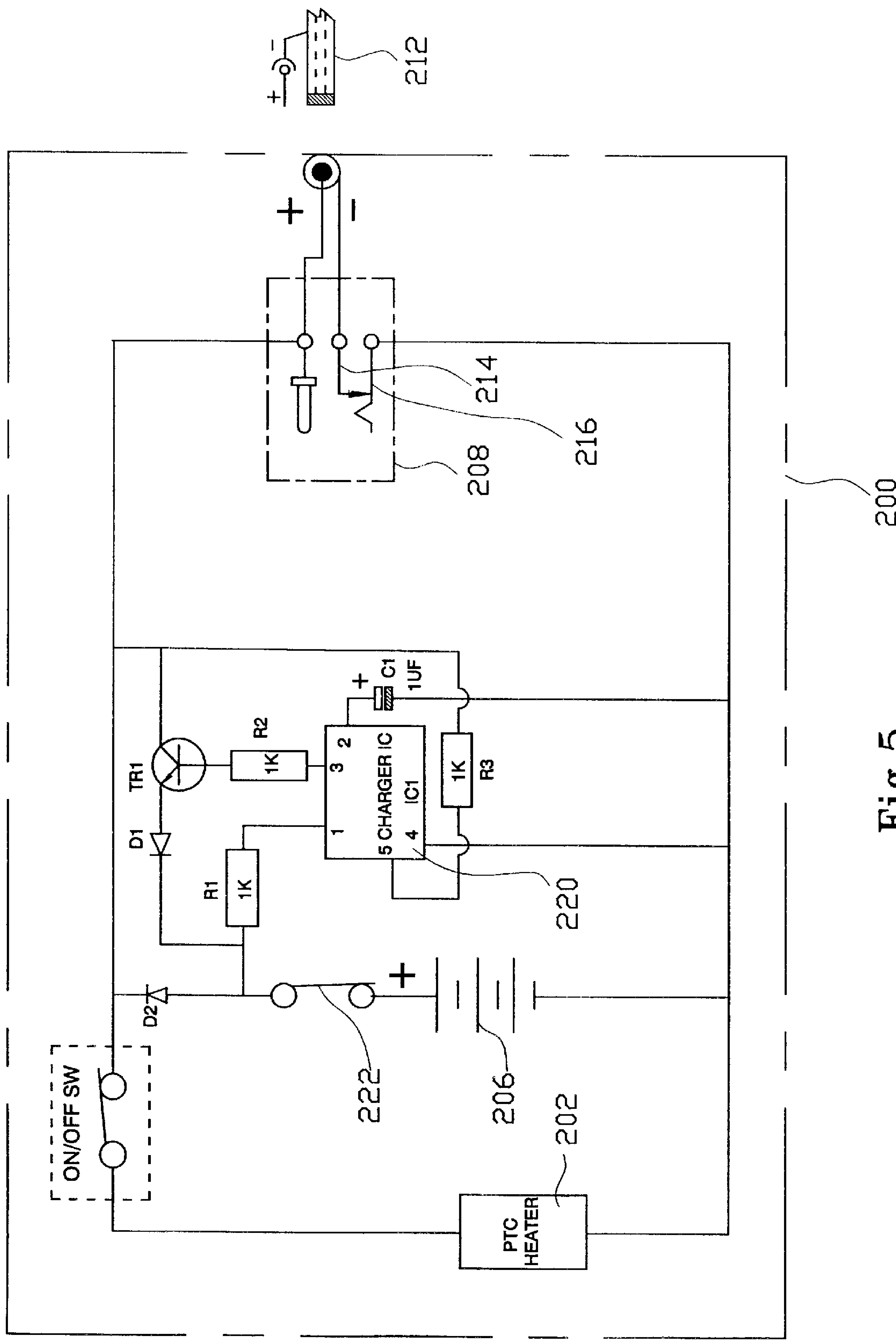


Fig.4



212
200
208
214
216
220
222
206
202
ON/OFF SW
PTC HEATER
5 CHARGER IC
IC1
TR1
D1
D2
R1
1K
R2
1K
R3
1K
C1
1UF
1
2
3
4
+
-

Fig.5

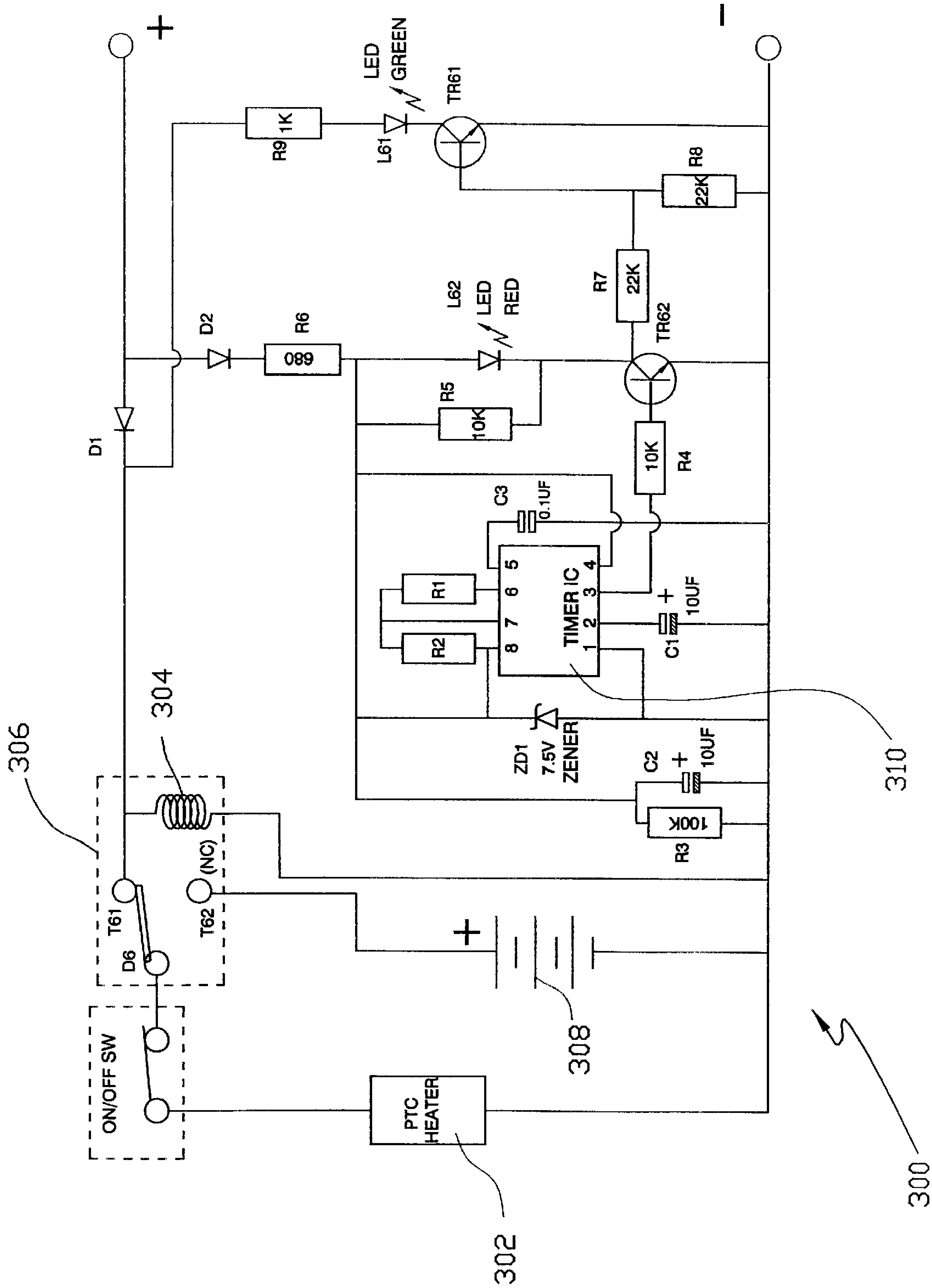
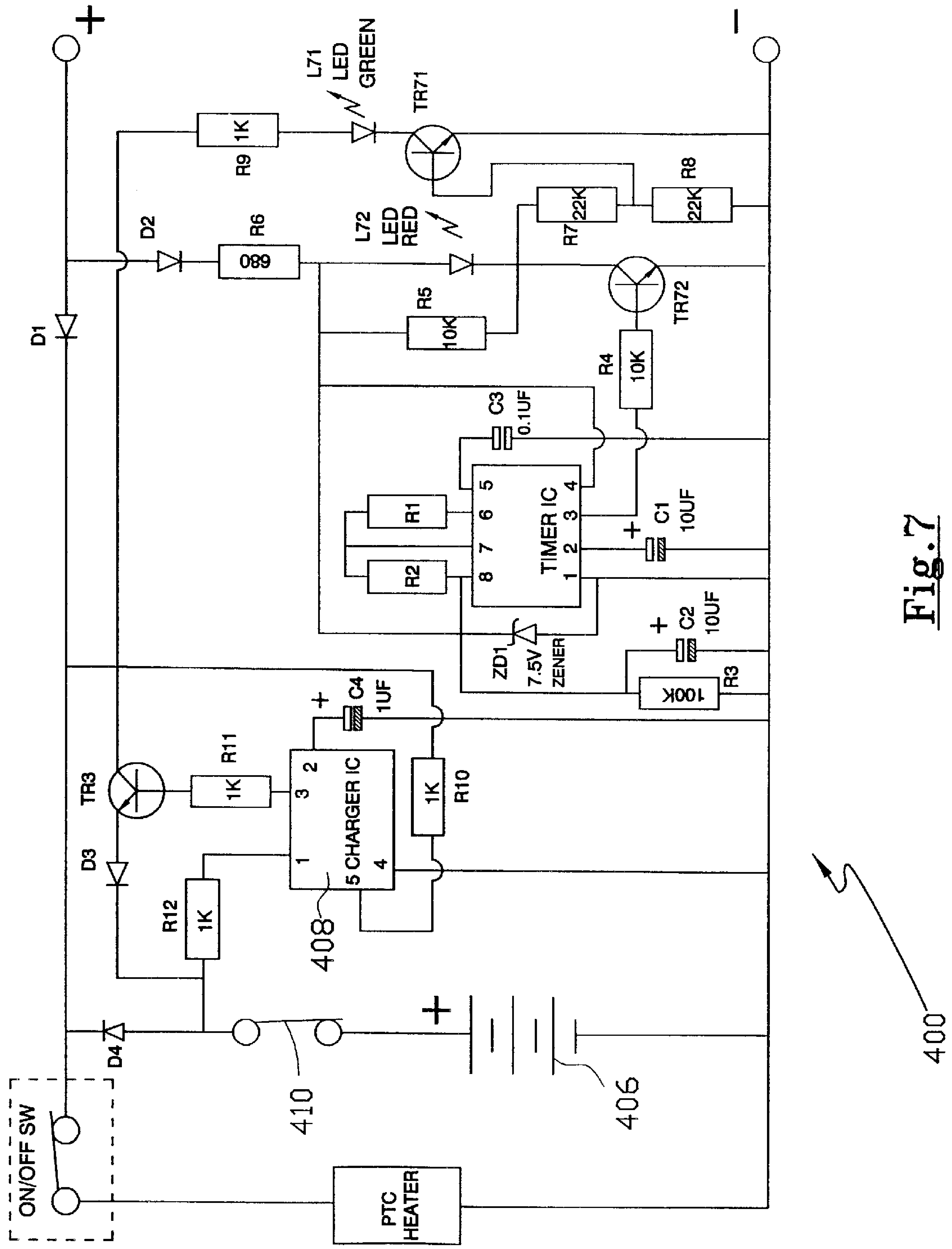

+
-
LED GREEN
TR61
L61
R9
1K
R8
22K
R7
22K
L62
LED RED
TR62
D2
R6
089
R5
10K
D1
10K
R4
C3
0.1UF
R1
R2
TIMER IC
5 6 7 8
4 3 2 1
10UF
C1
ZD1
7.5V
ZENER
C2
10UF
100K
R3
306
304
(NC)
T61
T62
D6
ON/OFF SW
PTC HEATER
308
310
302
300

Fig.6



+
-
L71
LED
GREEN
TR71
R9
1K
R8
22K
R7
22K
D2
R6
680
L72
LED
RED
D1
R5
10K
TR72
R4
10K
C3
0.1UF
R1
R2
TIMER IC
C1
10UF
C2
10UF
ZD1
7.5V
ZENER
R3
100K
C4
1UF
TR3
R11
1K
CHARGER IC
R10
1K
D3
R12
1K
408
D4
410
406
400
ON/OFF SW
PTC
HEATER

Fig. 7

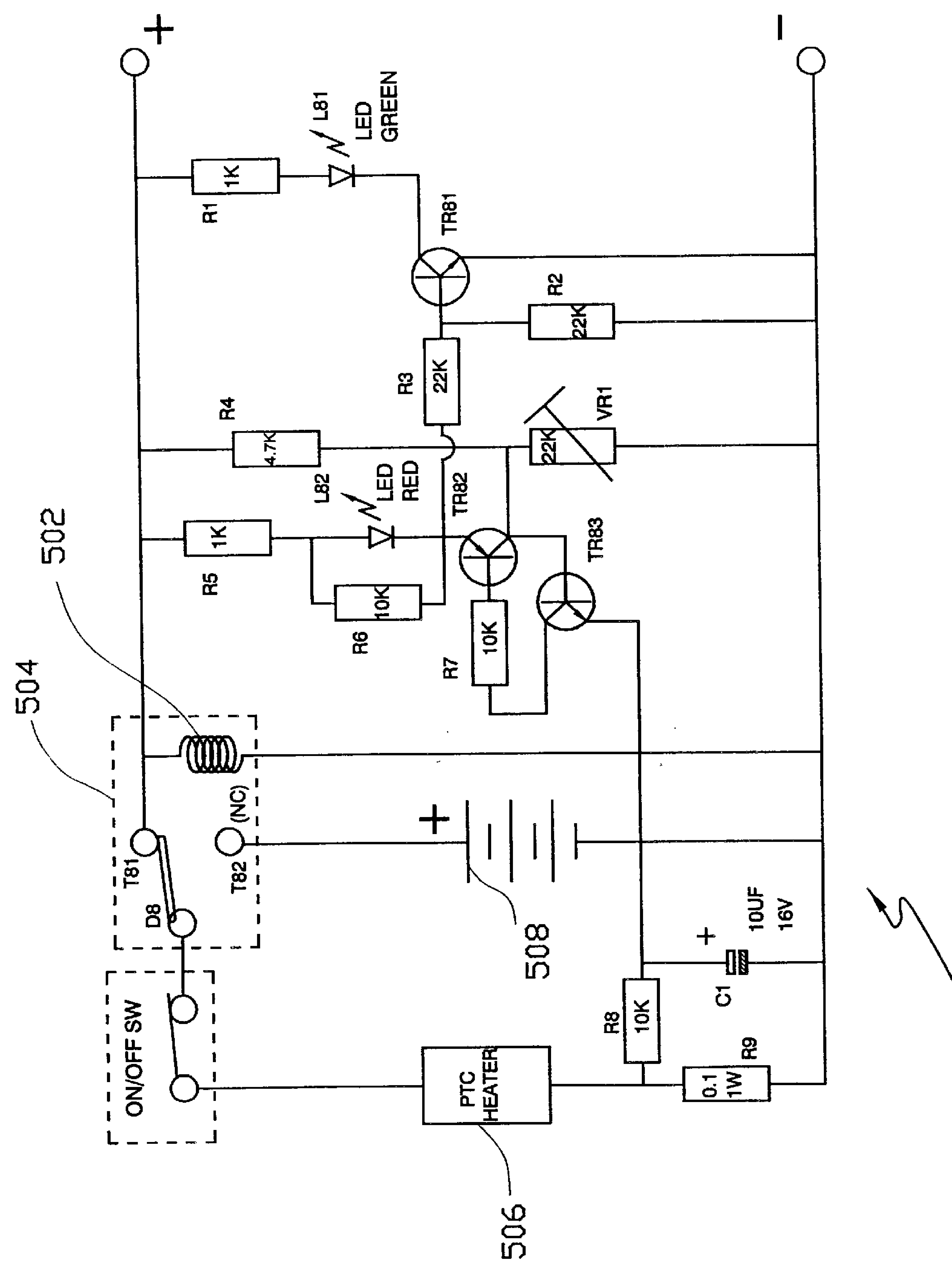

+
-
R1
1K
L81
LED
GREEN
TR81
R2
22K
R3
22K
R4
4.7K
VR1
22K
L82
LED
RED
TR82
R5
1K
R6
10K
R7
10K
TR83
502
504
T81
D8
(NC)
T82
ON/OFF SW
508
+
10UF
16V
C1
R8
10K
R9
0.1
1W
PTC
HEATER
506
500

Fig.8

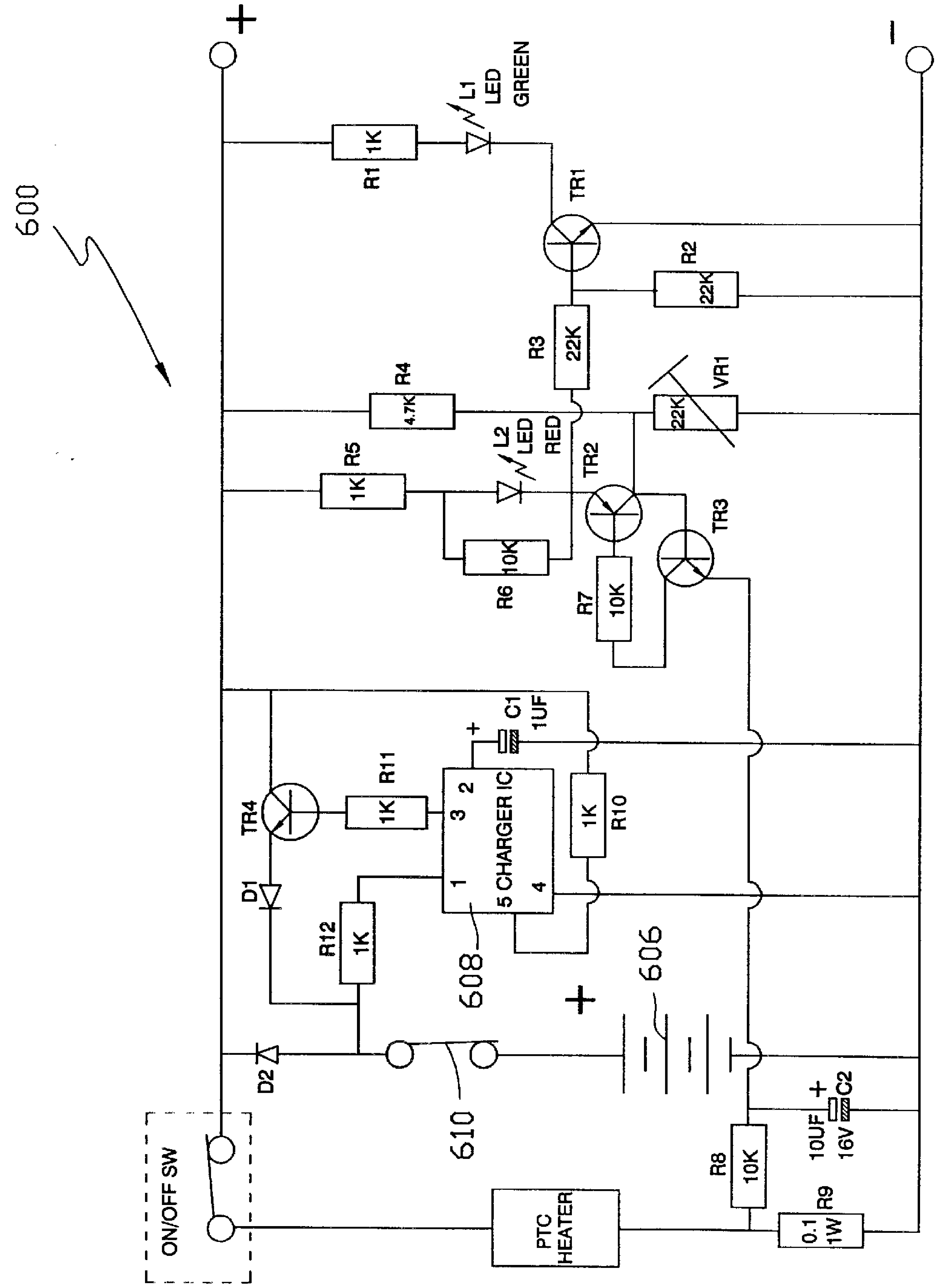
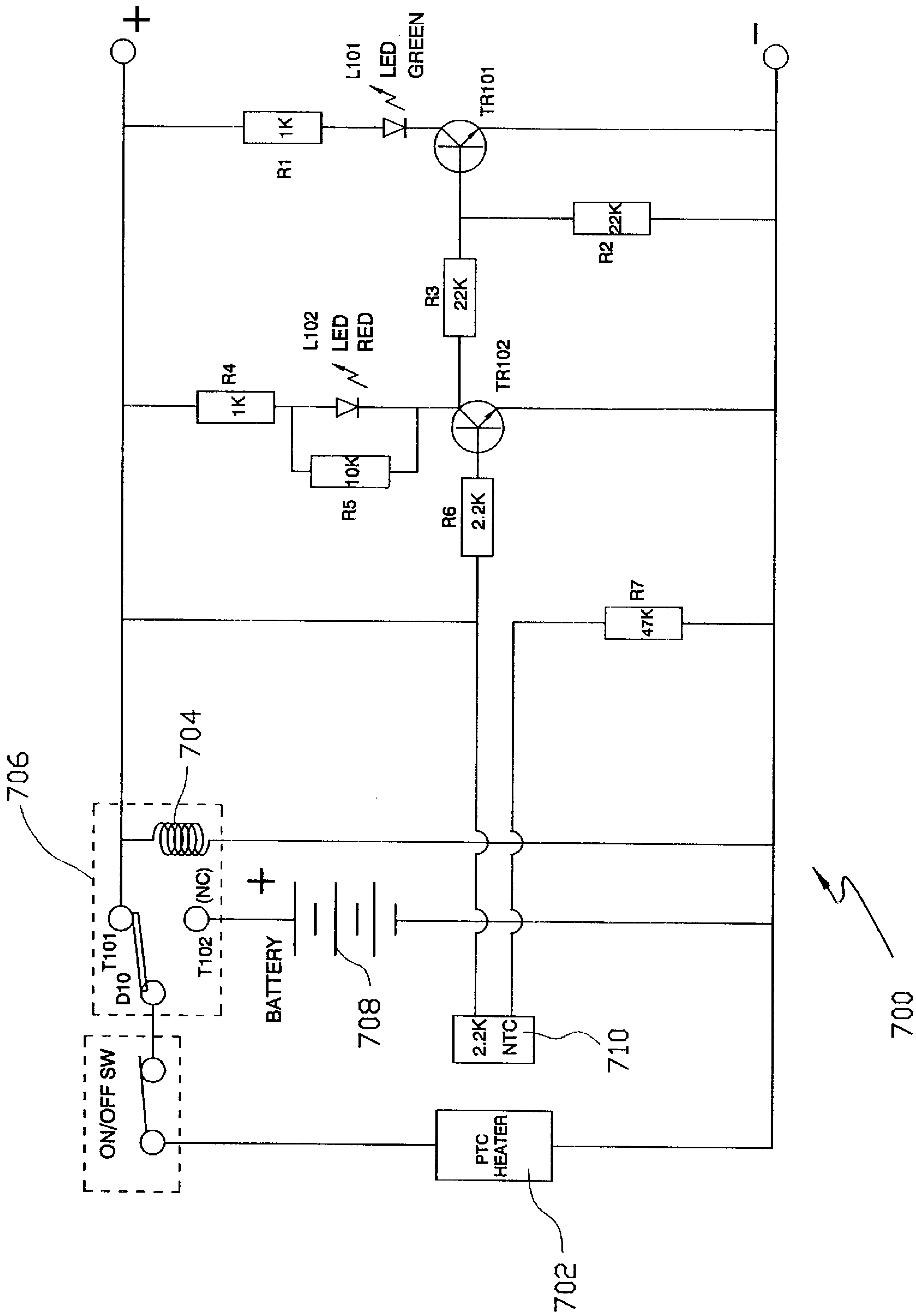

600
+
-
R1 1K
L1 LED GREEN
TR1
R2 22K
R3 22K
R4 4.7K
VR1 22K
R5 1K
L2 LED RED
TR2
R6 10K
R7 10K
TR3
TR4
R11 1K
C1 1UF
+
CHARGER IC
1
2
3
4
5
R10 1K
D1
R12 1K
608
606
+
D2
610
ON/OFF SW
PTC HEATER
R8 10K
C2 10UF 16V
+
R9 0.1 1W

Fig.9



+
-
R1
1K
L101
LED
GREEN
TR101
R2
22K
R3
22K
L102
LED
RED
R4
1K
TR102
R5
10K
R6
2.2K
R7
47K
704
706
T101
D10
T102
(NC)
BATTERY
708
2.2K
NTC
710
ON/OFF SW
PTC
HEATER
702
700

Fig.10

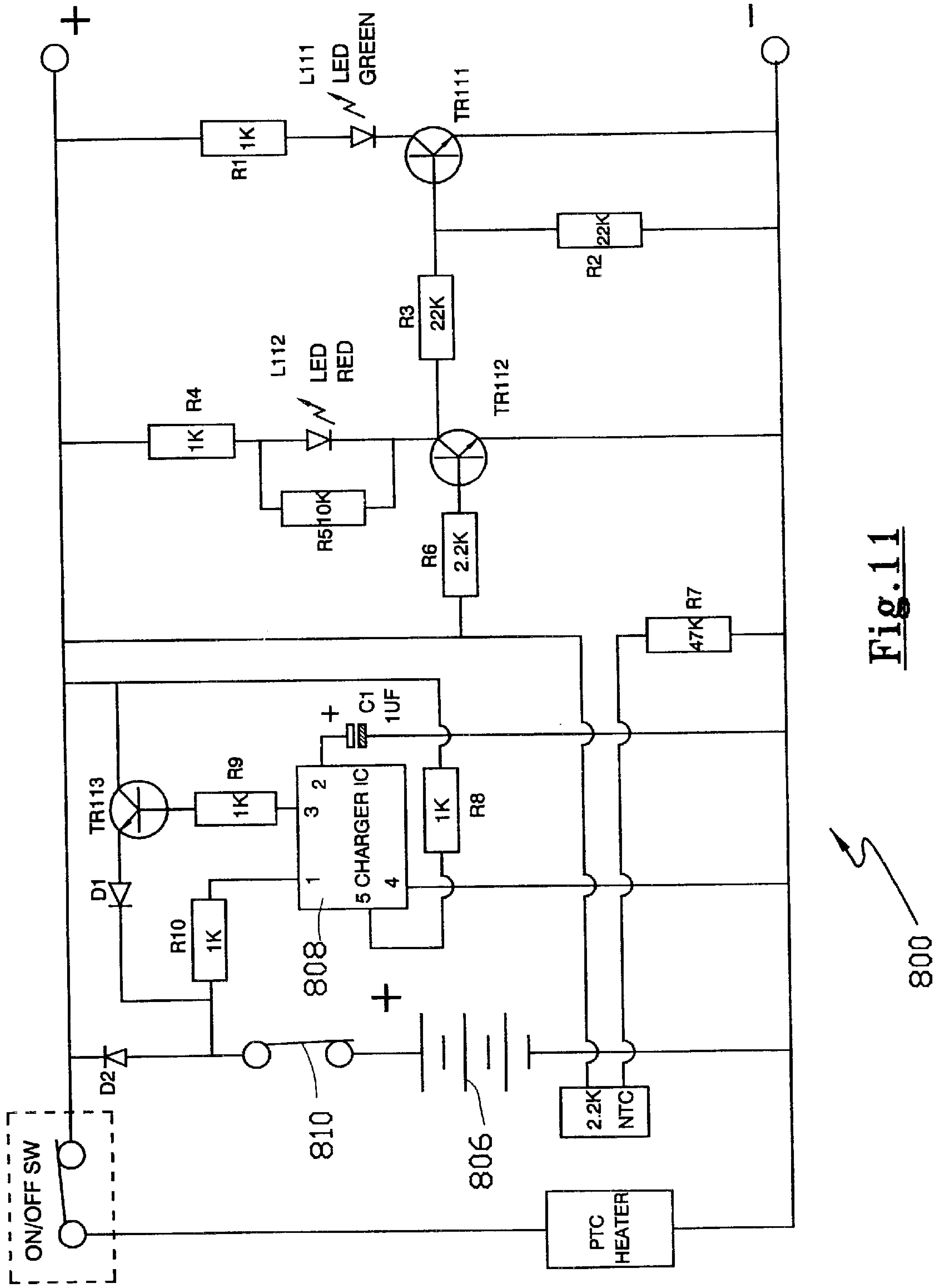

+
-
R1
1K
L111
LED
GREEN
TR111
R2
22K
R3
22K
L112
LED
RED
R4
1K
R5
10K
TR112
R6
2.2K
R7
47K
C1
1UF
+
TR113
R9
1K
CHARGER IC
1
2
3
4
5
R8
1K
D1
R10
1K
808
+
D2
810
806
2.2K
NTC
ON/OFF SW
PTC
HEATER
800

Fig. 11

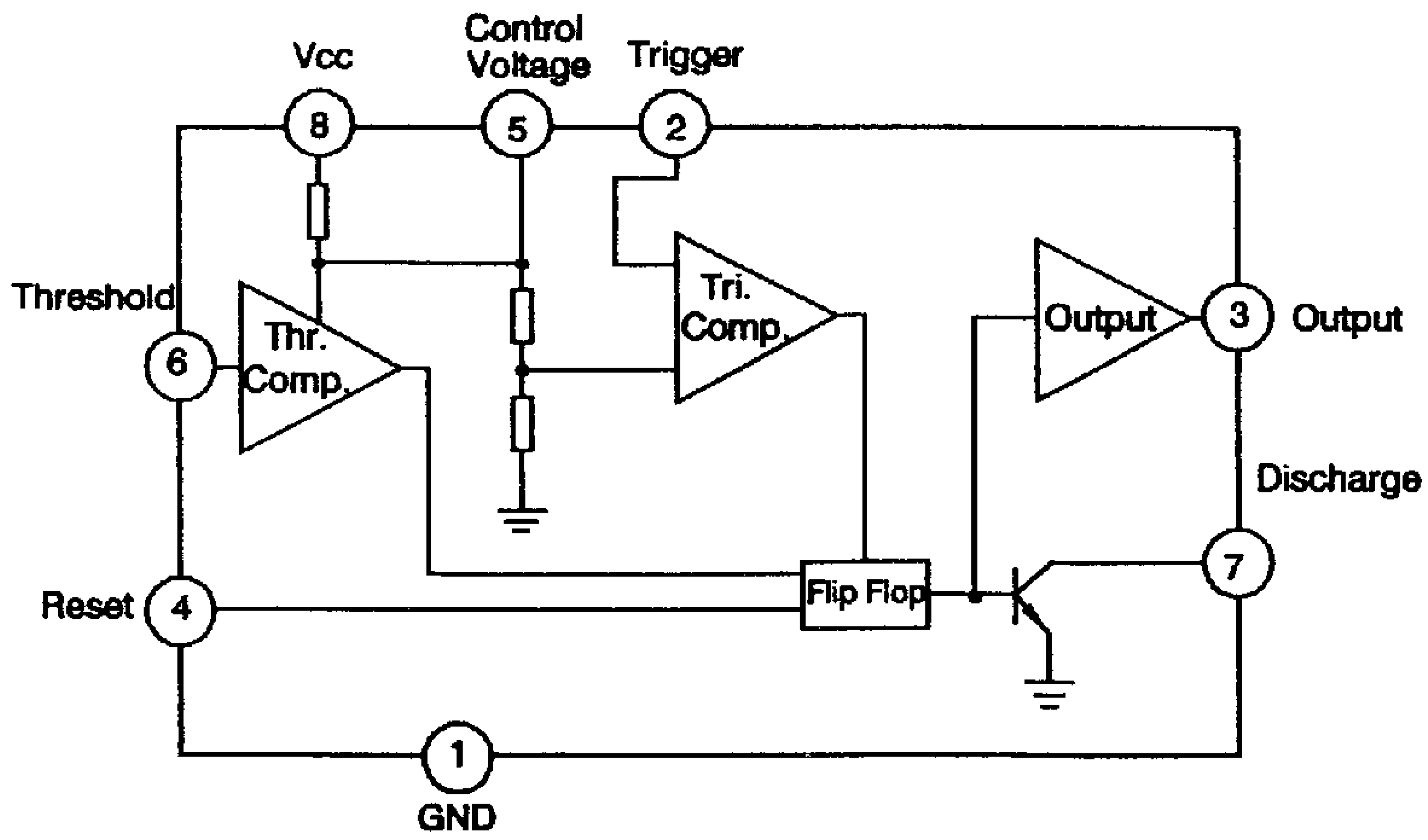

Vcc
Control Voltage
Trigger
8
5
2
Threshold
6
Thr. Comp.
Tri. Comp.
Output
3
Output
Discharge
7
Reset
4
Flip Flop
1
GND

Fig.12

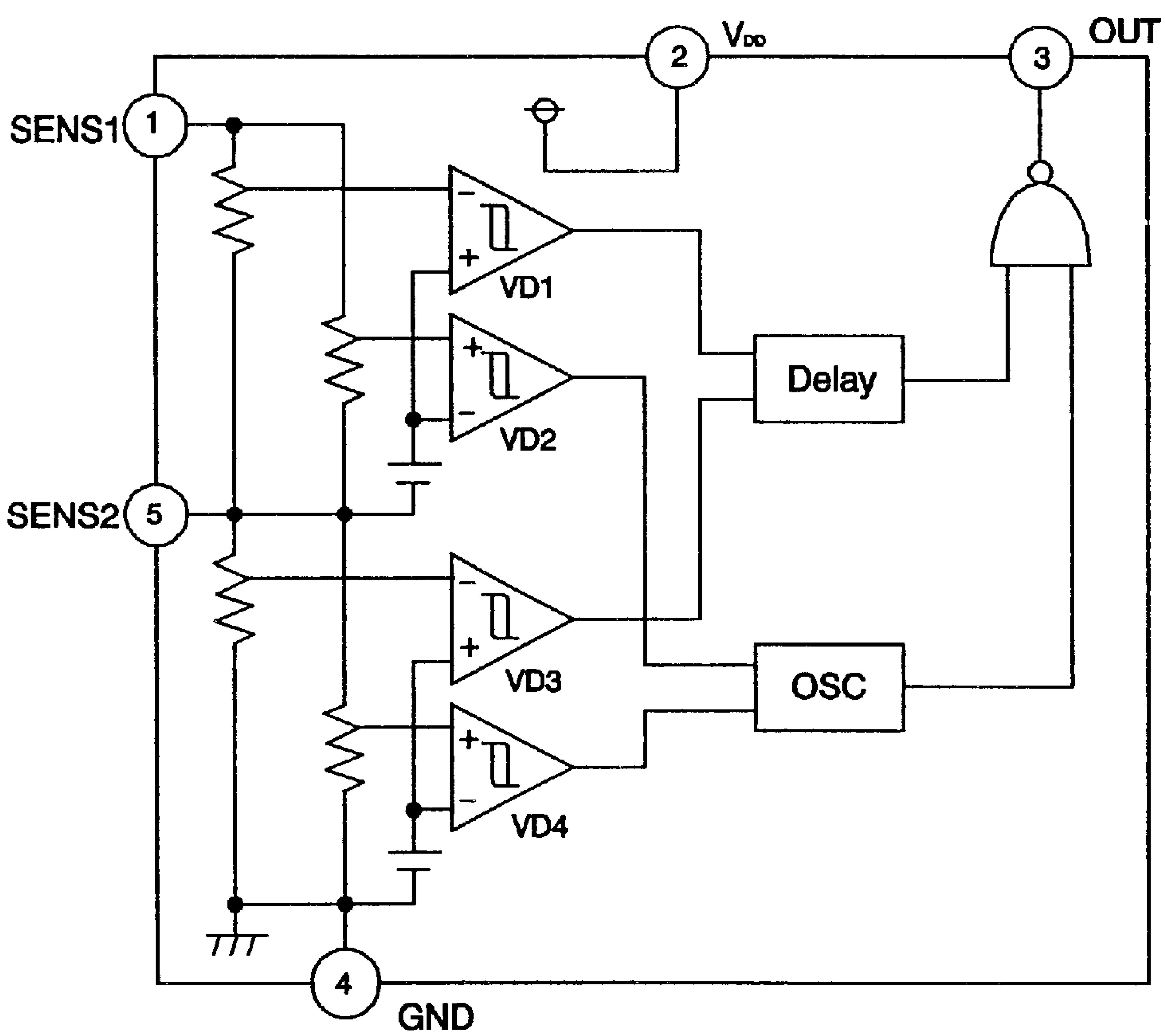

2
VDD
3
OUT
SENS1
1
VD1
VD2
Delay
SENS2
5
VD3
OSC
VD4
4
GND

Fig.13

ELECTRIC APPLIANCE WITH A PTC HEATING MEMBER AND A METHOD OF OPERATING SAME

This invention relates to an electric appliance with a positive temperature coefficient (PTC) heating member, and a method of operating such an appliance, which may, for example, be an electric hair curler.

PTC thermistors, a type of PTC heating member, are made of polycrystalline ceramic on a base of barium titanate by doping a small amount of rare earth element, e.g. yttrium (Y), lanthanum (La), etc. PTC thermistors of various shapes and specifications may, for example, be obtained from Ohizumi Manufacturing Co., Ltd. of Japan.

FIG. **1** of the accompanying drawings is a graph showing a typical electrical resistance/temperature relationship of a PTC thermistor. The electrical resistance of the PTC thermistor is measured at the ambient temperature at a voltage sufficiently low to avoid self-heating. The temperature at which the electrical resistance of PTC thermistor begins to increase rapidly is called the "curie temperature" (T_c), which is defined as the temperature at which the resistance value is twice that of the minimum resistance value (R_{min}). For the particular thermistor whose resistance/temperature relationship is shown in FIG. **1**, the temperature coefficient ox, between any two temperatures (T_1, T_2) is given by equation (1) below:

$$\alpha = 2.303\frac{\log\frac{R_2}{R_1}}{T_2 - T_1}100\%/^\circ\text{C}. \tag{1}$$

As the electric voltage applied to a PTC thermistor increases, the temperature of the PTC thermistor will rise slowly by self-heating. When the temperature approaches and eventually exceeds the curie temperature (T_c), the electric current will begin to decrease, as shown in FIG. **2**, which shows the relationship between the electric current passing through the PTC thermistor relative to the applied voltage, at various ambient temperatures. As can be seen in FIG. **2**, such a relationship is influenced by the ambient temperature. When the electric voltage is gradually increased, the temperature of the PTC will gradually increase by self-generated heat. When the temperature reaches around the curie temperature (T_c), it shows a negative current characteristic, namely that as voltage continues to increase, the electric current decreases. This is shown in more detail in FIG. **3**, which shows the relationship between the electric current passing through the PTC thermistor with time.

It can be seen in FIG. **3** that when an electric voltage is applied to the PTC thermistor, there will be a attenuation of the current. Initially, a very large electric current will flow through the PTC thermistor. As the time of application of this voltage increases, the electric current will decrease sharply until it reaches a low level, whereupon it will remain relatively constant. This low level is well below the normal working current of a heat generating resistor, and therefore there is, in the long run, an advantage of using PTC thermistor for generating heat, in preference to a resistor.

However, the characteristic shown most clearly in FIG. **3** has hindered the use of PTC thermistors as heating elements in electric appliances with heating members, in particular those appliances with batteries (rechargeable or otherwise) for operating the heating members. As discussed above, when an electric voltage is applied to the PTC thermistor, a large electric current will initially be drawn from the power source to start up the PTC thermistor. In cases where the power source are batteries, each time of starting the electric appliance will significantly shorten the normal useful life of the batteries, as batteries are not designed to provide such a large flow of electric current. This cannot be adequately compensated, even if the electric current decreases with the passage of time to a low level.

It is thus an object of the present invention to provide an electric appliance with a PTC heating member, and a method of operating such an electric appliance, in which the aforesaid shortcoming is mitigated, or at least to provide a useful alternative to the public.

According to a first aspect of the present invention, there is provided an electric appliance with a positive temperature coefficient (PTC) heating member and at least a first electric power source, wherein said PTC heating member is adapted to be powered by said first electric power source and at least a second electric power source, characterized in that said PTC heating member is adapted to be powered by said second electric power source when said electric appliance is started, and to be subsequently powered by said first electric power source.

According to a second aspect of the present invention, there is provided a method of operating an electric appliance with a positive temperature coefficient (PTC) heating member and at least a first electric power source, including steps (a) of powering said PTC heating member by at least a second electric power source; (b) powering said PTC heating member by said first electric power source, characterized in powering said PTC heating member by said second electric power source when said electric appliance is started, and powering said PTC heating member by said first electric power source subsequently.

Embodiments of the present invention will now be described, by way of examples only, and with reference to the accompanying drawings, in which:

FIG. **1** shows a typical relationship between the electrical resistance and the temperature of a PTC thermistor;

FIG. **2** shows relationship between the electric current passing through a PTC thermistor relative to the electric voltage applied thereto, at various ambient temperatures;

FIG. **3** shows the relationship between the electric current passing through a PTC thermistor with time;

FIG. **4** is a diagram showing an electric appliance incorporating a PTC thermistor, according to a first embodiment of the present invention;

FIG. **5** is a diagram showing an electric appliance incorporating a PTC thermistor, according to a second embodiment of the present invention;

FIG. **6** is a diagram showing an electric appliance incorporating a PTC thermistor, according to a third embodiment of the present invention;

FIG. **7** is a diagram showing an electric appliance incorporating a PTC thermistor, according to a fourth embodiment of the present invention;

FIG. **8** is a diagram showing an electric appliance incorporating a PTC thermistor, according to a fifth embodiment of the present invention;

FIG. **9** is a diagram showing an electric appliance incorporating a PTC thermistor, according to a sixth embodiment of the present invention;

FIG. **10** is a diagram showing an electric appliance incorporating a PTC thermistor, according to a seventh embodiment of the present invention;

FIG. **11** is a diagram showing an electric appliance incorporating a PTC thermistor, according to an eighth embodiment of the present invention;

FIG. 12 shows the circuitry of a timing integrated circuit which may be used in the embodiments shown in FIGS. **6** and **7**; and

FIG. **13** shows a block diagram of an integrated circuit for regulating the charging of the battery in the electric appliances of the embodiments shown in FIGS. **5**, **7**, **9** and **11**.

Referring to FIG. **4**, such shows a circuit diagram of an electric appliance, e.g. an electric hair curler, according to a first embodiment of the present invention, generally designated as **100**. The electric appliance **100** includes a positive temperature coefficient (PTC) heater **102** electrically connected via an optional on/off switch **104** to one or more batteries **106**, and a power jack **108**. The batteries **106** may, for example, be disposable batteries, e.g. dry batteries, or car batteries. The power jack **108** is electrically connected to a receiver **110** designed for connection with a power plug **112** connectable, probably via a transformer, to an outside electric power source, which may, for example, be a municipal a.c. source at 220 v or a car battery. The basic principle is that the batteries **106** are of a voltage of not more than 50 volts, and the outside electric power source is of a higher electric power than the batteries **106**.

When the power plug **112** is connected with the power jack **108**, electric power is supplied to the PTC heater by the outside electric power source. Simultaneously, a movable contact arm **114** of the power jack **108** is pushed out of contact from a stationary contact arm **116**, whereby the power supply from the batteries **106** is disconnected. The electric appliance **100** then starts, and the PTC heater **102** heats up under the power supplied by the outside electric power source. A user may, when he so desires, manually remove the power plug **112** from the power jack **108**, to disconnect the electric appliance **100** from the outside electric source. Upon removal of the power plug **112** from the power jack **108**, the movable contact arm **114** returns, e.g. upon the action of a biasing force of a spring, to its normal state to contact and electrically connect the stationary contact arm **116**, so that the PTC heater **102** is now powered, and thus heated up or kept warm, by the batteries **106**, in place of the outside electric power source.

By way of such an arrangement, the very large initial electric power for starting the PTC heater **102** will be borne by the outside electric power source, and not by the batteries **106** in the appliance **100**. The on/off switch **104** may be operated to connect or disconnect the electrical connection between the PTC heater **102** and the batteries **106** and/or the power jack **108**, through which the PTC heater **102** is connected with the outside electric power source.

FIG. **5** shows a circuit diagram of an electric appliance according to a second embodiment of the present invention, generally designated as **200**. In this electric appliance **200**, when a power jack **208** is connected with a power plug **212**, a movable contact arm **214** will be moved to contact and electrically connect with a stationary contact arm **216**, so that if the power plug **212** is connected, e.g. via a transformer, to an outside electric power source, the electric appliance will be started, and a PTC heater **202** will be heated up, due to the passing of electricity therethrough. At the same time one or more rechargeable batteries **206** will be recharged by the outside electric power source, under the control of a charger integrated circuit (IC) **220**. The rechargeable batteries **206** are also protected against overcharging by a resettable device **222** produced and traded by Raychem Circuit Protection, a division of Tyco Electronics, under the trade name PolySwitch. This device is a kind of polymeric PTC non-linear thermistor that limits the magnitude of electric current that may pass threrethrough.

At this time, the entire circuit is powered by the outside electric power source, even after the PTC heater **202** is sufficiently heated up to its steady state. When the power plug **212** is removed from the power jack **208**, the movable contact arm **214** will disengage from the stationary contact arm **216** and return to its normal open position, whereupon the PTC heater **202** is then powered, and thus heated up or kept warm, by the rechargeable batteries **206** only, in place of the outside electric power source.

FIG. **13** shows a block diagram of a charger IC which may be used in the embodiment shown in FIG. **5** discussed above. This can be used as a protector for rechargeable Ni—Cd or Ni—MH batteries. Such an IC may be one traded by Ricoh Corporation, of USA, under its R5440N2xxA Series, which can detect over-voltage and halt a charging current. It is composed of Over-voltage detectors VD**1**, VD**3**, Low-voltage detectors VD**2**, VD**4**, an oscillator circuit, a reference unit, a delay circuit, and a logic circuit.

FIG. **6** shows a circuit diagram of an electric appliance according to a third embodiment of the present invention, generally designated as **300**. When the appliance **300** is connected to an outside electric power source (not shown), electric current flows through a coil **304** of a relay **306**, thus attracting a pole D**6** of the relay **306** to connect with T**61** position, thus breaking up the electrical contact between a PTC heater **302** with one or more batteries **308** in the appliance **300**. The PTC heater **302** starts to heat up under the power from the outside electric power source, and a timer integrated circuit (IC) **310** starts to count down. The time T to be counted down is determined by the value of a capacitor C**1** and resistors R**1**, R**2**, according to equation (2) below:

$$T=0.693(R1+2R2)*C1 \qquad (2)$$

The values of C**1**, R**1** and R**2** are such that the resultant count down time T is of a sufficient duration to allow the PTC heater **302** to attain its relatively steady and low current state.

At the same time, the timer IC **310** triggers on a transistor TR**62**, so that electric current flows through a red light emitting diode (LED) L**62** and the transistor TR**62**, whereupon the LED L**62** lights up. When the timer IC **310** counts down to zero, the timer IC **310** resets the transistor TR**62** to off. As the transistor TR**62** is off, no electric current will flow through the LED L**62** and the transistor TR**62**. Electric current instead flows through a transistor TR**61**, and thereby to light up a green LED L**61**, indicating that the PTC heater **302** has attained its relatively steady and low current state, and is thus ready for use.

When the electric appliance **300** is disconnected from the outside electric power source, no electric current will flow through the coil **304**, whereupon the pole D**6** will return to its normally closed (NC) position to connect with T**62**. The PTC heater **302** is then electrically connected with and powered, and thus kept warm or heated up, by the batteries **308**.

An integrated circuit which may be used as the timer IC **310** may be one traded by Unisonic Technologies Co., Ltd., of Taiwan, under their serial No. UTC NE555, an exemplary block diagram of which is shown in FIG. **12**. When operated in an astable mode, the frequency and duty cycle of such an IC are controlled by two external resistors and one capacitor, i.e. R**1**, R**2** and C**1** in FIG. **6**.

A circuit diagram of an electric appliance, generally designated as **400**, made in accordance with a fourth embodiment of the present invention is shown in FIG. **7**. This electric appliance **400** differs from the third embodiment discussed above mainly in that there are provided in the electric appliance **400** a number of rechargeable batteries **406**. A charger integrated circuit (IC) **408** and a resettable device **410** are also provided to protect the rechargeable batteries **406** from being overcharged. When the electric appliance **400** is electrically connected with an outside electric power source (not shown), the rechargeable batteries **406** are recharged under the control of the charger IC **408**, and the protection of the resettable device **410**.

FIG. **8** shows a circuit diagram of an electric appliance according to a fifth embodiment of the present invention, generally designated as **500**. When this electric appliance **500** is started by being electrically connected with an outside electric source (not shown), electric current will flow through a coil **502** of a relay **504**, whereby a pole D**8** is attracted to contact and electrically connect with a position T**81**. A large inrush electric current is thus drawn from the outside electric power source to power and heat up a PTC heater **506**. As the circuit current is high, a transistor TR**82** is triggered to switch on, so that the electric current flows through a red LED L**82** and the transistor TR**82**, thus lighting up the red LED L**82**.

When the PTC heater **506** is sufficiently heated up to the steady state, the current becomes low. When a transistor TR**83** senses that the electric current flowing through a resistor R**9** decreases to below a predetermined reference level, the transistor TR**82** is switched off. The value of the predetermined reference level is determined by the value of the power of the PTC heater **506**, and the value of the input voltage of the outside electric power source. The values of resistors R**8** and R**9** may have to be changed in response to changes in the value of the power of the PTC heater **506**, and that of the input voltage of the outside electric power source.

Upon switching off of the transistor TR**82**, no current flows through the red LED L**82** and the transistor TR**82**. The electric current flows instead through a transistor TR**81**, and thereby to light switch on a green LED L**81**, signalling that the PTC heater **506**, and thus the electric appliance **500**, is ready for use. At this point, the whole electric appliance **500** is still powered by the outside electric power source.

When the electric appliance **500** is disconnected from the outside electric power source, no electric current will flow through the coil **502** of the relay **504**, whereupon the pole D**8** will return to its normally closed (NC) position to connect with T**82**. The PTC heater **502** is then electrically connected with and powered, and thus kept warm or heated up, by batteries **508**.

A circuit diagram of an electric appliance, generally designated as **600**, made in accordance with a sixth embodiment of the present invention is shown in FIG. **9**. This electric appliance **600** differs from the fifth embodiment discussed above mainly in that there are provided in the electric appliance **600** a number of rechargeable batteries **606**. A charger integrated circuit (IC) **608** and a resettable device **610** are also provided to protect the rechargeable batteries **606** from being overcharged. When the electric appliance **600** is electrically connected with an outside electric power source (not shown), the rechargeable batteries **606** are recharged under the control of the charger IC **608**, and the protection of the resettable device **610**.

A circuit diagram of an electric appliance, generally designated as **700**, made in accordance with a sixth embodiment of the present invention is shown in FIG. **10**. When the electric appliance **700** is electrically connected with an outside electric power source (not shown), an electric current flows through a coil **704** of a relay **706**, which attracts a pole D**10** to contact and electrically connect with a position T**101**. A PTC heater **702** then heats up under the power of the outside electric power source. At the same time, a negative temperature coefficient (NTC) thermistor **710** positioned adjacent to the PTC heater **702** is at a high resistance state. A transistor TR**102** is triggered to switch on, so that electric current flows through a red LED L**102** and the transistor TR**102**, whereupon the red LED L**102** lights up.

When the temperature of the PTC heater **702** is sufficiently high, as the NTC thermistor **710** is near to the PTC heater **702**, it will be heated up by the heat generated by the PTC heater **702**, so that its electric resistance decreases. When the temperature of the NTC thermistor **710** rises to a predetermined reference level, its electric resistance will fall to a level at which the transistor TR**102** will be switched off. Upon the transistor TR**102** being switched off, no electric current will flow through the red LED **102** and the transistor TR**102**. Electric current instead flows through a transistor TR**101**, whereupon a green LED **101** will light up, indicating that the PTC heater **702** is at a steady current state, ready to be used. In the meantime, the electric appliance **700** is powered by the outside electric power source.

When the electric appliance **700** is disconnected from the outside electric power source, no current flows through the coil **704**, whereupon the pole D**10** will return to its normally closed (NC) position to connect with T**102**. The PTC heater **702** is then electrically connected with and powered, and thus kept warm or heated up, by batteries **708**.

The distance between the PTC heater **702** and the NTC thermistor **710**, the power of the PTC heater **702**, and the input power voltage, will all affect the time duration before which the temperature of the NTC thermistor **710** rises to the predetermined reference level. The NTC thermistor **710** may be in direct contact with the PTC heater **702**, or be positioned adjacent to it without touching it.

NTC thermistors which may be used in the electric appliance **700** discussed above may be ones traded by Ohizumi Manufacturing Co., Ltd. of Japan under their NGR series, with an operating temperature range of −55° C. to 300° C., or NRC series, with an operating temperature range of −20° C. to 100° C. NTC thermistors are resistors with high negative temperature coefficient of resistance. The relationship between its electrical resistance and temperature may be approximated by equation (3) below:

$$R_1 = R_0 \exp B\left(\frac{1}{T_1} - \frac{1}{T_0}\right) \tag{3}$$

in which R_0 is the initial electrical resistance of the NTC thermistor at temperature T_0 measured in Kelvin, and R_1 is the electrical resistance at temperature T_1. B is a constant for a given thermistor, and may be approximated by equation (4) below:

$$B = (\ln R_1 - \ln R_0) \Big/ \left(\frac{1}{T_1} - \frac{1}{T_0}\right) \tag{4}$$

The temperature coefficient of resistance β of the NTC thermistor can be approximated by equation (5) below:

$$\begin{aligned} \beta &= \frac{1}{R}\frac{dR}{dT} \\ &= -\frac{B}{T^2} * 100\% \end{aligned} \tag{5}$$

The relationship between the power P (which equals voltage (V) multiplies current (I)) applied to an NTC thermistor at ambient temperature (T_0) and the consequent temperature rise (T_1-T_0) due to self-heating can be approximated by equation (6) below:

$$P = V * I = \delta(T_1 - T_0) \quad (6)$$

in which δ is the dissipation constant, normally measured in mW/° C.

A circuit diagram of an electric appliance, generally designated as **800**, made in accordance with an eighth embodiment of the present invention is shown in FIG. **11**. This electric appliance **800** differs from the seventh embodiment discussed above mainly in that there are provided in the electric appliance **800** a number of rechargeable batteries **806**. A charger integrated circuit (IC) **808** and a resettable device **810** are also provided to protect the rechargeable batteries **806** from being overcharged. When the electric appliance **800** is electrically connected with an outside electric power source (not shown), the rechargeable batteries **806** are recharged under the control of the charger IC **808**, and the protection of the resettable device **810**.

It should be understood that the above only illustrates examples whereby the present invention may be carried out, and that various modifications and/or alterations may be made thereto without departing from the spirit of the invention. In particular, it should be understood that the value of the various electronic components given in the drawings are examples only, and may be changed with the change of the voltage of the outside electric power source and the power of the PTC heater in the electric appliance.

It should also be understood that certain features of the invention, which are, for clarity, described in the context of separate embodiments, may be provided in combination in a single embodiment. Conversely, various features of the invention which are, for brevity, described in the context of a single embodiment, may also be provided separately or in any appropriate sub-combinations.

What is claimed is:

1. An electric appliance with a positive temperature coefficient (PTC) heating member and at least a first electric power source, wherein said PTC heating member is adapted to be powered by said first electric power source and at least a second electric power source, characterized in that said PTC heating member is adapted to be powered by said second electric power source when said electric appliance is started, and to be subsequently powered by said first electric power source.

2. An electric appliance according to claim **1** further characterized in that said PTC heating member is adapted to be powered subsequently by said first electric power source in place of said second electric power source.

3. An electric appliance according to claim **1** or **2** further characterized in that said second electric power source is of a larger electric power than said first electric power source.

4. An electric appliance according to claim **1** further characterized in that first electric power source is of not more than 50 volts.

5. An electric appliance according to claim **1** further characterized in that said first electric power source includes at least one disposable battery.

6. An electric appliance according to claim **1** further characterized in that said first electric power source is a rechargeable electric power source and is adapted to be recharged by said second electric source when said PTC heating member is powered by said second electric source.

7. An electric appliance according to claim **6** further characterized in including means for controlling the recharging of said first electric power source by said second electric power source.

8. An electric appliance according to claim **7** further characterized in that said controlling means includes at least an integrated circuit.

9. An electric appliance according to claim **6** further characterized in including means for protecting said first electric power source from being overcharged by said second electric power source.

10. An electric appliance according to claim **9** further characterized in that said protecting means comprises at least a current limiting device.

11. An electric appliance according to claim **10** further characterized in that said current limiting device comprises at least a polymeric PTC member.

12. An electric appliance according to claim **1** further characterized in that change of power source from said second power source to said first power source is adapted to be carried out manually.

13. An electric appliance according to claim **1** further characterized in including means for indicating when said PTC heating member reaches a predetermined temperature.

14. An electric appliance according to claim **13** further characterized in including at least one negative temperature coefficient (NTC) thermistor for sensing the temperature of said PTC heating member.

15. An electric appliance according to claim **14** further characterized in that the electric resistance of said NTC thermistor is adapted to fall to a predetermined level when the PTC heating member reaches said predetermined temperature.

16. An electric appliance according to claim **1** further characterized in that including means for indicating when the electric current flowing through said PTC heating member falls below a predetermined level.

17. An electric appliance according to claim **1** further characterized in including means for indicating when said PTC heating member has been powered by said second electric power source for a predetermined period time.

18. An electric appliance according to claim **17** further characterized in that said predetermined period of time is measured by at least an integrated circuit.

19. A method of operating an electric appliance with a positive temperature coefficient (PTC) heating member and at least a first electric power source, including steps (a) of powering said PTC heating member by at least a second electric power source; (b) powering said PTC heating member by said first electric power source, characterized in powering said PTC heating member by said second electric power source when said electric appliance is started, and powering said PTC heating member by said first electric power source subsequently.

20. A method according to claim **19** further characterized in that said first electric power source subsequently powers said PTC heating member in place of said second electric power source.

21. A method according to claim **19** or **20** further characterized in that said second electric power source is of a larger electric power than said first electric power source.

22. A method according to claim **19** further characterized in that first electric power source is of a voltage of not more than 50 volts.

23. A method according to claim **19** further characterized in that said first electric power source includes at least one disposable battery.

24. A method according to claim **19** further characterized in that said first electric power source is a rechargeable electric power source.

25. A method according to claim **24** further characterized in including a step (c) of recharging said first electric power source by said second electric source when said PTC heating member is powered by said second electric source.

26. A method according to claim **25** further characterized in including a step (d) of controlling the recharging of said first electric power source by said second electric power source.

27. A method according to claim **26** further characterized in that said step (d) is carried out by at least an integrated circuit.

28. A method according to claim **25** further characterized in including a step (e) of protecting said first electric power source from being overcharged by said second electric power source.

29. A method according to claim **28** further characterized in that said step (e) is carried out by at least a current limiting device.

30. A method according to claim **29** further characterized in that said current limiting device comprises at least a polymeric PTC member.

31. A method according to claim **19** further characterized in including a step (f) of manually changing the power source for operating said electric appliance from said second power source to said first power source.

32. A method according to claim **19** further characterized in including a step (g) of changing the power source for operating said electric appliance from said second power source to said first power source when said PTC heating member reaches a predetermined temperature.

33. A method according to claim **32** further characterized in including a step (h) of sensing the temperature of said PTC heating member.

34. A method according to claim **33** further characterized in that said step (h) is carried out by at least one negative temperature coefficient (NTC) thermistor.

35. A method according to claim **34** further characterized in that the electric resistance of said NTC thermistor falls to a predetermined level when said PTC heating member reaches said predetermined temperature.

36. A method according to claim **32** further characterized in including a step (i) of visually indicating when the electric resistance of said NTC thermistor falls to a predetermined level.

37. A method according to claim **19** further characterized in including a step (j) of changing the power source for operating said electric appliance from said second power source to said first power source when the electric current flowing through said PTC heating member falls below a predetermined level.

38. A method according to claim **37** further characterized in including a step (k) of visually indicating when the electric current flowing through said PTC heating member falls below said predetermined level.

39. A method according to claim **19** further characterized in including a step (l) of changing the power source for operating said electric appliance from said second power source to said first power source after said PTC heating member is powered by said second electric power source for a predetermined period of time.

40. A method according to claim **39** further characterized in that said predetermined period of time is measured by at least an integrated circuit.

41. A method according to claim **39** or **40** further characterized in including a step (m) of visually indicating when said PTC heating member has been powered by said second electric power source for said predetermined period of time.

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